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A STUDY OF THE ETCHING FIGURES OF THE HEXAGONAL-ALTERNATING TYPE OF CRYSTALS

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(Continued from page 61)

PHENACITE

The phenacite crystals used are from the Crystal Peak locality, Florissant, and Mt. Antero, Chaffee Co., Colorado. Those from the former locality are flat rhombohedrons, with the prism zone almost completely lacking; the latter locality yields crystals of the elongated type, with the prism $11\bar{2}0$ the dominant form. The prism was first investigated.

Prism

Phenacite, being quite insoluble, was not etched after repeated attempts with the more common acids, consequently the fused alkalis were used. At first the crystal was immersed for only three seconds in fused NaOH, but even this was sufficient to produce distinct etchings, which appeared as very minute elongated depressions extending parallel to the prism edges; other than this no definite form could be assigned to them. Repeated immersions for several seconds each gradually developed more distinct figures possessing three sides, but still very narrow and elongated in form, the two longer sides terminating in a single point, the third side extending in an oblique direction across the prism face. This, then, being the most primitive stage of development indicates a more rapid solution in the direction of the c axis. Immersion to the extent of twenty seconds in the fused NaOH was sufficient to produce well-defined figures as seen in Photo 12 (see frontispiece). They have a definite orientation, with their longer axes extending parallel to the intersections of the prism faces. The two longer sides are curved outward, and are intersected by two short, straight oblique lines which form the upper and lower terminations of the figures. The upper boundary is definite, but the lower one is very dim and uncertain. The figures do not conform to any possible planes of symmetry, but their position on adjacent faces indicates the presence of an alternating axis c .

The etch figures of another small crystal from the same locality were investigated by means of fused KOH. As before, the crystal was immersed for only two or three seconds at a time, and examined after each immersion, in order to note the development of the figures, and if possible to compare the figures resulting from the action of the two different solvents. At first no etching was visible on the prism, but very minute grooves or striae cut the face of the rhombohedron diagonally, indicating the more soluble nature of this form. Only after immersion of several minutes did solution begin, and even then the etchings were visible only as the smallest pits, slightly elongated, very similar to those previously described as produced by NaOH. Five minutes immersion produced as the ultimate form a quadrilateral figure, well defined and distinct. (See Photo 13.) The figures are bounded by four straight lines, all differing in length, the two longer being nearly parallel and extending parallel to the prism edges. Unlike the NaOH figures, there are no curved lines, and the terminations instead of appearing as indefinite broken margins are definite lines; the one at the narrower end of the figure is about perpendicular to the longer axis, while the other intersects it obliquely. The figures may or may not have a face parallel to the prism; in the absence of this plane the deeper part of the figures lies well to one end. Like the NaOH figures, those produced by KOH bring out the symmetry of the type.

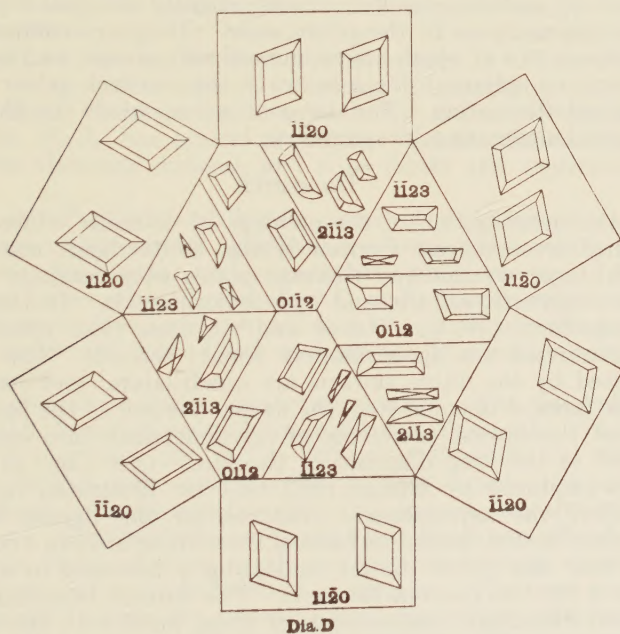
Etch figures were also obtained by fused borax, but the action of this solvent was so violent that the tendency was to corrode the face rather than to etch it. The first indication of etching was the appearance of many minute depressions, elongated diagonally across the prism; these upon continued immersion became intergrown to such an extent that individual forms were completely obliterated. Fused KF, likewise, acted with such vigor that individual figures were difficult to obtain. Photo 14 represents the crystal face after five seconds immersion. The darker portions represent the small basal faces of the etchings. The etch figures are very irregular, and reveal no planes of symmetry.

Rhombohedron

Crystals from the Crystal Peak locality were selected for the purpose of etching the rhombohedron. The $10\bar{1}1$ face is quite soluble if submerged in fused NaOH, so that a little caution is necessary to avoid intergrowth. The less perfect portions of the face very quickly assume a dull corroded appearance, but occasional distinct figures may be seen which are dagger-like, and composed of three faces, one plane and two curved surfaces (See dia. C). The broad end of the figure occupies a position parallel to $d-r$. The primitive forms are shorter and broader. Like all of the phenacite figures previously described, these forms possess no planes of symmetry and accord with the type.

NATURAL ETCH FIGURES ON PHENACITE

Among the phenacite crystals in the Princeton University collection are several gem crystals from San Miguel de Peracicora, Brazil, possessing a variety of forms, and most beautifully naturally-etched, as illustrated in Dia. D. The + and - rhombohedrons of the second order are the best developed faces and occur in groups of two, one + and one - form; the pairs are separated by the faces of the π form, which truncates the alternate intersections of $\bar{1}\bar{1}23$ and $2\bar{1}\bar{1}3$. The natural etchings of $\bar{1}\bar{1}23$ and



$2\bar{1}\bar{1}3$ are almost identical in outline, but are differently oriented on the two forms. In general, the figures which represent the final stage of development are slightly elongated forms, the longer margins of which are straight parallel lines, intersected by two shorter curved lines, which bound the ends of the figures. One of the lateral margins being shorter than the other gives the figures an asymmetrical appearance. The more rounded terminations are turned poleward with the shorter lateral boundaries adjacent to the edge $01\bar{1}2-2\bar{1}\bar{1}3$. Various stages of development are represented but all are asymmetrical. The plus and minus forms do not become congruent if revolved about a vertical axis, indicating the difference of molecular configuration of the faces.

The form $01\bar{1}2$ is marked by elongated quadrilateral figures, one end of which is rectangular, the other oblique. These etchings are similar in position and form to those just described, but they differ in the absence of curved margins. They are elongated parallel to the intersections $01\bar{1}2-2\bar{1}\bar{1}3$ and $01\bar{1}2-\bar{1}\bar{1}23$, with the shorter lateral boundary adjacent to $2\bar{1}\bar{1}3$. As in the figures of $\bar{1}\bar{1}23$ and $2\bar{1}\bar{1}3$, those of $01\bar{1}2$ may or may not possess a face at the bottom of the pit. The etchings by their form and position indicate an absence of symmetry planes and verify the presence of the alternating axis c .

The prism $11\bar{2}0$ is the best developed form of this zone, and is marked by definite rhombic figures, slightly elongated parallel to the intersections of the prism zone. They are composed of five planes, two of which are asymmetrically placed, and by their positions on adjacent faces indicate the vertical axis c to be hexagonal-alternating. The mineral as a whole is therefore hexagonal-alternating in symmetry.

DOLOMITE

In the investigation of the etchings of dolomite white rhombohedral crystals from Canton Wallis, Switzerland, were used. Several large crystals and cleavage plates were carefully etched by two solvents, sulfuric and hydrochloric acids. In each case the same form $10\bar{1}1$ was etched and the time thru which solution continued was approximately twenty seconds. The figures produced by the dilute sulfuric are quadrilateral and composed of four faces of unequal size; the deeper portion of the figure lies without the center, producing an asymmetrical form elongated parallel to the long diagonal of the face. (See Dia. E.) The figures produced by boiling 15% HCl are illustrated in Photo 11. Here the asymmetrical character of the figures is very apparent; the four bounding faces of the etching meet in a common point near one end of the pit, indicating a difference in size and shape of the two faces at the ends. The lateral bounding faces are also dissimilar; intersections of these faces with the crystal face are very different, the one straight, the other decidedly curved. The figures are therefore, not symmetrical to planes and indicate the hexagonal-alternating symmetry of dolomite, which by some writers has been assigned incorrectly to the calcite type.

CLEANING FERBERITE SPECIMENS.—The ferberite crystals from Boulder County, Colorado, are often dull on the surface owing to the presence of a film of silica. This coating can be removed by immersion in dilute hydrofluoric acid, which dissolves silica but does not attack the ferberite, so that the crystals of the latter come out clean and brilliant. Inferior specimens can often be considerably improved by this treatment. The work must of course be done in hard rubber, lead or platinum vessels, and the hands carefully protected from contact with the acid.

HORACE B. PATTON,
Colorado School of Mines.

GILPINITE, A NEW URANIUM MINERAL FROM
COLORADO.¹

BY ESPER S. LARSEN AND GLENN V. BROWN

U. S. Geological Survey and Bucknell University

In seeking for johannite and uranopilite for optical study one of the authors (E. S. L.) found in many of the museums specimens of a crystalline mineral from Gilpin County, Colo. The specimens were labeled johannite in some museums, and uranopilite in others, but a microscopic examination showed that the specimens are all of the same mineral, and a chemical analysis proves that it differs from any known mineral. The name gilpinite is proposed for the species from its occurrence in Gilpin County, Colo. A specimen labeled uranocher (uranopilite) Cornwall, Eng., kindly furnished the authors by Colonel Roebling, of Trenton, N. J., has optical properties that are almost identical with the Colorado mineral, and it no doubt also represents gilpinite.

Physical Properties.—Gilpinite occurs as pale greenish yellow to canary yellow crystal aggregates coating a green copper ore or a black pitchblende, and associated with gypsum. It has a vitreous luster, a hardness of about 2, and a specific gravity above that of methylene iodide, which is 3.32. It is infusible or difficultly fusible but turns black on heating. It is readily soluble in dilute acids.

The optical properties are characteristic. The mineral is in minute, lath-shaped crystals up to 0.3 mm. in length. The axial angle is very near 90° and is somewhat variable and the dispersion of the optic axes is strong to very strong. In part the crystals are optically negative with $\rho > v$, in part optically positive with $\rho < v$. Crystals lying on the flat face show two sets of polysynthetic twin lamellae, nearly at right angles and resembling the albite and pericline twins of plagioclase. The more common set appears to have the twinning and composition plane normal to the laths and parallel to the elongation. The less common set has the twinning and composition plane nearly at right angles to the other set and across the laths. A crystal showing the two sets of twins is represented in Figure 2. The extinction on the flat face, Y to elongation and composition face, is 5° to 8° for yellow light with considerable dispersion for white light. X is apparently normal to this flat face and crystals turned on edge give parallel extinction. The mineral is therefore probably monoclinic, the flat face being (010) and the elongation c. Other faces are probably (101), $(\bar{1}01)$ and (001). The chief twinning is on (100), the less common on (001). The optic orientation is

¹ Published with permission of the Director of the U. S. Geological Survey.

$X=b$, $Y \wedge c = 5\frac{1}{2}-8^\circ$. The outline and optic orientation of two crystals lying on face (010) with angles as measured under the microscope are shown in Figures 1 and 2. The indices of refraction were measured by the immersion method with a probable error not exceeding ± 0.003 ; the optical properties vary slightly in the different specimens as is shown by table 1. The optical properties as measured on four specimens of gilpinite are shown in table 1 together with the properties of zippeite and uranopilite, the minerals most resembling gilpinite, for comparison. The four specimens of gilpinite show only a slight difference in their optical properties while the zippeite and the uranopilite are very

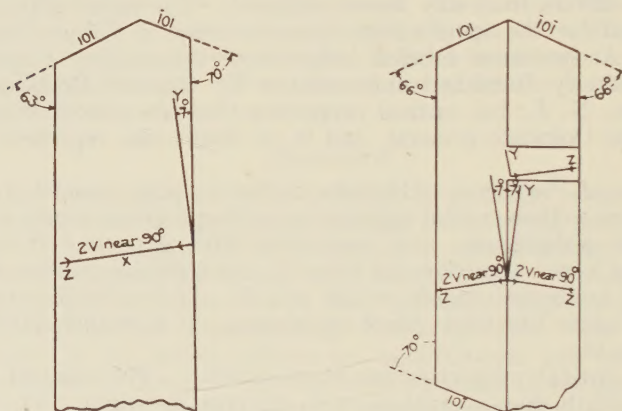


Figure 1—Trace of crystal of gilpinite on (010), showing optical orientation.
2—Trace of crystal of gilpinite on (010), twinned after (100) and (001), and showing optical orientation.

different altho the habits of the three are sufficiently similar to suggest some relationship.

Chemical Properties.—Gilpinite is readily soluble even in very dilute acids. Material for analysis was carefully picked by hand from a specimen from the U. S. National Museum² and this was separated from associated gypsum by methylene iodide. It was not found possible to separate all the pitchblende. A microscopic examination of the material used for the analyses showed, however, only gilpinite and opaque pitchblende.

² Catalog No. 49,090; specimen collected by Dr. W. F. Hillebrand, and transmitted to the Museum by the U. S. Geological Survey in 1890; in the original records labeled simply "uraninite undergoing alteration," the secondary mineral herein named gilpinite not being specially noted.

Only a small amount of material could be thus obtained; the better sample weighed 0.22 gram, and a somewhat less pure one, which seemed sufficiently good for qualitative examination, amounted to 0.07 gram. This latter was heated several times with dilute hydrochloric acid (1 acid to 10 H₂O, by volume) with intervening filtration. The insoluble black portion amounted to 24.00% of the original material. The greenish yellow acid

TABLE 1.—Optical Properties of Gilpinite, Zippeite and Uranopilite.

	1. Gilpinite Colorado (U. S. Nat. Mus.)	2. Gilpinite Colorado (Calif. Miner.)	3. Gilpinite Colorado (Am. Mus. Nat. Hist)	4. Gilpinite Cornwall (Col. Roeb- ling)	Zippeite ^a	Uranop- ilite ^a
Color	Greenish- yellow to canary yellow	As in 1	As in 1	As in 1	Orange- yellow	Orange- yellow to greenish yellow
Pleoc. X	Colorless				Nearly colorless	Pale yellow
Y	Very faint yellow				Pale yellow	Pale yellow
Z	Pale green- ish to can- ary yellow				Deep yellow	Pale yellow
Opt. char.	+ or —	+	—	+	—	+
2V _{Na}	near 90°	near 90°	near 90°	near 90°	large	moderate
Disp. of 2V	$\rho < V$ or $\rho > V$ strong to very strong	$\rho < V$ strong	$\rho > V$ strong	$\rho < V$ strong	$\rho < V$? not strong	$\rho < V$ extreme
α	1.577	1.577	1.575	1.575	1.620	1.621
β	1.596	1.597	1.594	1.592	1.680	1.623
γ	1.616	1.616	1.611	1.612	1.720	1.631
Habit	Laths (010)	Laths (010)	Laths (010)	Laths (010)	Laths (010)	Laths (010)
Opt. orient.	X $\perp$ laths Y Δ elong. 5½°	X $\perp$ laths Y Δ elong. 5½°	X $\perp$ laths Y Δ elong. 8°	X $\perp$ laths Y Δ elong. 5°	X $\perp$ laths Z Δ elong. 32°	X $\perp$ laths Y Δ elong. 15°

^a Unpublished data; measurements by E.S.L.; specimens from Col. Roebing

solution upon systematic qualitative analysis gave tests for copper, uranium, iron, sodium, potassium, and sulfuric acid; the absence of calcium and phosphorus was also established. A test solution containing known amounts of these elements in the approximate proportions indicated by the bulk of the precipitates was then subjected to analysis as a check upon the methods to be used in the analysis of the purified material.

The purer sample was treated by boiling with several portions of dilute hydrochloric acid (1:10 by vol.), the black residue filtered off, ignited and weighed. The greenish yellow filtrate was heated to boiling and the sulfuric acid precipitated and weighed as barium sulfate. Copper and lead were obtained as sulfides in the acid solution from the barium sulfate precipitate, the precipitated sulfides dissolved in nitric acid, the free nitric acid removed by sulfuric acid and the lead ultimately weighed on a Gooch crucible as PbSO_4 . Copper was precipitated in the acid

TABLE 2.—Analysis of Gilpinite and Related Minerals.

	1	1a	1b	2	3	4
Gangue	19.64					
H ₂ O—	1.50	1.66	} 767 4x192			
H ₂ O+	10.08	12.15		5.59	17.69	15.23
SO ₃	12.44	15.45	193 1x193	20.02	13.06	17.36
UO ₃	45.67	56.72	198 1x198	67.72	67.86	62.04
CuO	4.67	5.80	73 5.99	.....	.....	5.21
FeO	3.84 ^a	4.77	66 1x182	0.20	.....	.....
PbO	0.67	0.82	4 182	.....	.....	.....
Na ₂ O	1.55	1.93	31 8	.....	.....	.....
K ₂ O	0.56	0.70	8	.....	.....	.....
CaO	.....	.....	.....	.....	0.61	.....
Fe O ₃	.....	.....	.....	.....	0.17	.....
	100.62	100.00	RO.UO ₃ .SO ₃ . 4H ₂ O. R=Cu,Fe,Na ₂ .	CuO. 3UO ₃ . 3SO ₃ . 4H ₂ O	3UO ₃ . 2SO ₃ . 12H ₂ O	CuO. 3UO ₃ . 3SO ₃ . 12H ₂ O

^a A little Fe_2O_3 is present but the material available was insufficient for separation of the two states of iron.

1. Gilpinite from Gilpin County, Colo.; analysis by G. V. B.
- 1a. Analysis 1, free from gangue, computed to 100%. The gangue carried 0.80% H_2O — and 1.50% H_2O +
- 1b. Molecular ratios of 1a.
2. Johannite—quoted from Dana.
3. Zippeite—quoted from Dana.
4. Zippeite—quoted from Dana.

solution from the lead precipitate by hydrogen sulfide, the copper weighed as the oxide, dissolved in nitric acid and redetermined electrolytically. After removal of hydrogen sulfide from the copper and lead precipitates, uranium and iron were separated by ammonium hydroxide in hot solution. This precipitate, which was found to carry some barium, was purified, the uranium and iron reprecipitated, the precipitate ignited and weighed, dissolved in hydrochloric acid (sp. gr. 1.12) and the iron chloride extracted with ether (Skey method), the iron and uranium ultimately being weighed as their respective oxides. Excess of barium salts was

removed from the ammoniacal filtrate by ammonium carbonate reagent, the ammonium salts volatilized, and the sodium and potassium weighed as the combined chlorides; the respective elements were determined indirectly by solution of their chlorides and weighing the chlorine present as silver chloride. H_2O - and + were determined in a separate sample by heating at 105° and 200° .

All precipitates and filtrates were carefully worked over for impurities or traces which might have escaped detection. Water, gangue, uranium, and sulfuric acid were determined in duplicate samples. Since barium was found to contaminate the combined iron and uranium precipitate thrown down by ammonia, the excess barium chloride was removed in the duplicate prior to the precipitation of these elements. There was a tendency for small amounts of uranium to resist precipitation by ammonia, even when precipitated by very slight excess of carbonate-free ammonium hydroxide in hot solutions.

The results of the analyses are given in Table 2, together with analyses of related minerals for comparison. Chemically gilpinite is somewhat similar to analysis 4 of zippeite, but the difference is considerable and the optical properties of gilpinite and zippeite are very different, as has been shown in Table 1. If the two analyses of zippeite were made on homogeneous material they must represent two distinct minerals.

Conclusion.—The whole group of the secondary uranium minerals including sulfates, carbonates,³ phosphates, etc., is in need of entire revision. Some of the so-called species may thus be eliminated, a number of new species established, and our knowledge of the species and their relations made much more comprehensive. To accomplish this it will be necessary to study the minerals chemically, optically, and, where possible, crystallographically. The homogeneity of the material analyzed must be established by a careful optical study as most of the minerals are intimately mixed with gypsum and other impurities. The great need is for complete data, and all the properties should be measured on material identical with that analyzed.

The methods commonly used to determine the secondary uranium minerals are evidently inadequate; microscopic examination by one of the authors (E. S. L.) of about a hundred specimens of such minerals from the best museums of the country has shown that over one third were incorrectly labeled. The optical properties of these minerals are characteristic and with few exceptions the minerals can be quickly and accurately identified by a microscopic examination. This can be made on a few tiny crystals—very much less material than is required for the simplest qualitative tests. Unfortunately, many of the optical data are not tied to accurate chemical analyses.

³ An article on certain of these will appear in the July number of this magazine.

A TETRAGONAL IRON PHOSPHIDE FROM THE RUFF'S MOUNTAIN METEORITE.¹

EDGAR T. WHERRY

U. S. National Museum

In the course of his investigation of the composition of meteorites, Dr. George P. Merrill, Head Curator of Geology, U. S. National Museum, submitted a sample of the Ruff's Mountain iron to Dr. J. E. Whitfield for analysis. After dissolving the metallic constituents Dr. Whitfield obtained a bronze-colored residue, which qualitative analysis showed to be a phosphide of iron and nickel.² This was found to contain grains possessing crystal faces, and Dr. Merrill turned these over to the writer for crystallographic measurement. Two of them were found to show enough faces for this purpose, and proved to be tetragonal, agreeing very closely in angles with the artificial iron phosphides which have been measured by Mallard,³ Hlawatsch,⁴ and Spencer.⁵

TABLE 1—Measured and calculated angles of iron phosphide.

TETRAGONAL $c=0.346 \pm 0.001$

No.	Letter	Sym- bol	Crys- tals	Meas- ure- ments	Angles measured		Angles calculated	
					ψ	ϕ	ψ	ϕ
1	a'	010	2	5	0° 00' —	90° 00' —	0° 00'	90° 00'
2	m	110	2	5	45° 00' $\pm$ 15'	90° 00' —	45° 00'	90° 00'
3	o	111	2	5	45° 00' $\pm$ 60'	26° 05' $\pm$ 15'	45° 00'	26° 05'

The crystals average about one-half millimeter in diameter and are irregularly distorted, some of the faces being cavernous; the system of crystallization is not evident on superficial examination. The faces yield, however, fairly good reflections, the positions of which can be located in many cases within 5-10', unquestionable tetragonal symmetry being exhibited by the angular relations. The forms observed are: a (100), m (110), and o (111), and in addition there are rounded or poorly developed faces of other pyramids and prisms. All of the forms are incomplete, but there is hardly sufficient regularity in the suppression of faces to justify the assignment of the crystals to any particular hemihedral class.

In Table 1 are given the angles observed,⁶ in comparison with

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² A quantitative analysis is to be made and published, in connection with the complete description of this meteorite, in another place, (by Dr. Merrill).

³ *Compt. rend.* **92**, 933, 1881; *Bull. soc. franc. min.* **4**, 230, 1881.

⁴ *Min. petr. Mitt.* **22**, 497, 1903.

⁵ *Mineralog. Mag.* **17**, 340, 1915.

⁶ The Museum equipment not including a Goldschmidt two-circle goniometer, the measurements were made on the one in the Geophysical Laboratory of the Carnegie Institution, and thanks are herewith extended to Messrs. Wright and Merwin of that laboratory for their kindness in placing this instrument at the writer's disposal.

those calculated from the measurements of the authors above cited.

In addition, crystal 1 shows one face each of a prism close to 120, a pyramid not far from 122, and two other pyramids which yield the complicated symbols 357 and 562. Crystal 2 shows a face vicinal to the base, and one of a pyramid 152. Most of these faces may, however, be mere accidental surfaces where crystal growth was interrupted by other crystals, and until better evidence is obtained may be classed as doubtful.

A tetragonal iron phosphide has repeatedly been reported to occur in meteorites, and has in fact been assigned the name rhabdite (Rose, 1864). No crystallographic measurements have heretofore been obtained, however, adequate to prove that this supposed species represents anything more than distorted crystals of the well known isometric phosphide schreibersite. The present measurements demonstrate that a definite tetragonal mineral does exist in this meteorite.

NOTES AND NEWS

NOTES ON AN OCCURRENCE OF QUARTZ CRYSTALS. EDWARD F. HOLDEN. York, Pennsylvania.

Some very interesting quartz crystals are found on the farm owned by Mr. Kimmel, located two miles north of New Kingston, Cumberland Co., Pa. I recently had the good fortune to visit this locality in the company of two teachers from the York High School.

The crystals occur loose in the ground; the bedrock is a limestone, as in the case of the Herkimer, N. Y., crystals.

The most unusual crystals are those in which the form *m* is lacking, which are composed of the forms *r* and *z* only. These crystals occur in groups, each crystal being attached to another at the end of its vertical axis.

There are also crystals rivalling those of Herkimer in clearness, and crystals tinged with yellow or purple, besides smoky hued crystals. In addition opaque crystals are found, red or white in color; the opaqueness being due to internal fractures.

All of these crystals are doubly terminated and about $\frac{1}{2}$ to 1 inch long.

NOTES ON THE SPHEROSIDERITE FROM SPOKANE, WASHINGTON. L. P. GRATACAP. American Museum of Natural History.—Specimens of the sphaerosiderite recently found in Spokane (see *Am. Min.* 2, (3) 30, March, 1917). have been presented to the American Museum by Mr. Henry Fair, of that place. The two large specimens which have been placed on exhibition show dark greenish black spherules in cavities in the basic igneous rock. In one the surface is slightly silky-chatoyant, and in the

other it is minutely corrugated by scarcely emergent wrinkles in concretionary groups. In a third specimen the surface is smooth to the naked eye, but under a glass is minutely pustulate with flat disks.

The specific gravity was determined by the balance as 3.84. Mr. Fair submitted a sample to J. P. Maider, city chemist of Spokane, who reported as follows: FeCO_3 , 93.16; MnCO_3 , trace; CaCO_3 , 5.13; MgCO_3 , 1.83; sum 100.12, % Sp. gr. by pycnometer 3.673(?).

The optical properties of this siderite have been studied by Mr. E. S. Larsen of the U. S. Geological Survey, and will be described in a forthcoming number of the Journal of the Washington Academy of Sciences.

AN ELEMENTARY INTRODUCTION TO CRYSTALLOGRAPHY

J. P. WINTRINGHAM

Brooklyn, N. Y.

(Continued from page 66)

The symbol 111 calls for a plane that passes thru the ends of the a axis in front, the end of the b to the right or E and of c above or to the N. 111 gives a plane cutting a in front, b to the left or W, and c above or to the N.

$\bar{1}11$ is a plane cutting a to the back, b to the right, and c above, $1\bar{1}1$ a to the back, b to the left and c as before, above. These four would cut out a four sided pyramid. Four more which might be written at once by reversing the signs on the above, $11\bar{1}$, $\bar{1}1\bar{1}$, $1\bar{1}\bar{1}$ and $11\bar{1}$, would give an inverted pyramid with its base to the base of the first. The whole figure will make an octahedron.

If we take the four symbols 110 , $\bar{1}\bar{1}0$, $1\bar{1}0$ and $\bar{1}10$ they would indicate a square pillar or prism as the four 100 , 010 , $\bar{1}00$ and $0\bar{1}0$ did, but that had a face toward us, and this has an edge towards us. The three edges of a cube which meet in a point give us the direction of our three axes; here these four faces indicate that the two axes a and b are the same length or our pillar (or prism) would be diamond shaped, not square. These four faces are also in a zone parallel to c . They are properly called prism faces. They may be thought of as cutting off the corners of the first square pillars, whose face 100 is toward us. If they only cut off say half of the corners and left half we would have eight faces all in the c zone, the faces and edges all parallel to c .

The first four faces are the faces of a cube or are pinacoids, the last four are prism faces. As the cube has four faces parallel to b as well as parallel to c , this crystal form has four faces parallel to b ; they are 101 , $10\bar{1}$, $10\bar{1}$ and $10\bar{1}$, and indicate, if taken alone, a horizontal prism.

If the prism is square and not diamond shaped that shows that the lengths of the a and c axes are equal. If the crystal was drawn out that way it would be said to be elongated parallel to b .

These two sets taken together would make a closed form but not a perfect crystal.

There is plainly another set where the 0 is in the first place, 011, 011, 011, and 011.

They would make a prism parallel to a . The three pillars which combine to make a cube have for each pair two faces in common so the cube has only three times two, or six faces. Our last three prisms or pillars made with only one 0 in each symbol if combined would cut out or make a crystal form of three times four, or twelve faces, and for that reason is called the dodecahedron.

The dodecahedron has four faces meeting in a pyramid at each of the six ends of the axes; each face must thus go to the ends of two axes. As I have indicated each of these faces shows that two of the axes in the isometric system of crystals are equal. The octahedron, typified by (111), gives the indication by one of its faces that the three axes are all equal (but not so simply). These, the cube, the octahedron and the dodecahedron are the fundamental forms of the isometric system. There are four more forms in this system; they and all the forms in the other systems are derived from these three fundamental forms. The symbol 100 can only be modified by putting the 1 in each of three places and the 1 with the minus sign in three, making six planes or faces of the cube, the number of the permutations of the symbols being the same as the number of faces for the form it indicates. The same is true for the other crystal forms. The word form is used to indicate such a set of faces or planes. We use the symbol with a bracket to indicate the full set; thus:

(100) stands for all the faces of a cube.

(111) stands for all the faces of an octahedron.

(110) stands for all the faces of a dodecahedron.

The bracket is frequently put in by writers where it should be left out as only one face is intended. These crystal forms are not capable of any variation in the direction of their planes.

PROCEEDINGS OF SOCIETIES

THE PHILADELPHIA MINERALOGICAL SOCIETY

Wagner Free Institute of Science, April 12, 1917.

President Truettell in the chair. Fifteen members and two visitors were present. Mr. M. L. Jandorf and Dr. Herman Burgin were elected active members. Mr. William C. Knabe was appointed Treasurer to take the place of Mr. Oscar Streland who has resigned the office.

Mr. Oldach reported a trip to the Falls of French Creek Mines which are now in active operation. Fine specimens of pyrite, magnetite, calcite, and heulandite (new) were exhibited. Mr. Bengé reported the results of the trip of the Society to Mullica Hill, attended by seven members. Vivianite, beraunite and aragonite (besides eight or nine species of fossils) were obtained, the viv-

ianite and aragonite often occurring as perfect pseudomorphs after belemnites.

An exhibition of microscopic minerals constituted the program of the evening exhibits being made by Messrs. Bengé, Gordon, Hagey, Knabe and Trudell. Much interest was shown in the Perkiomen and Phoenixville minerals of Mr. Bengé, the Vesuvius minerals and the slide showing the growth of crystals of margaric acid of Mr. Gordon, and in the showy specimens of Mr. Hagey. Mr. Rothermel exhibited a small diamond mounted for the microscope.

FIELD EXCURSIONS

WEDNESDAY, JULY 4. Hellertown and Friedensville, Lehigh Co. Meet at 69th St. Terminal at 7.45 A. M.

SAMUEL G. GORDON, *Secretary*.

NEWARK MINERALOGICAL SOCIETY

The 16th meeting of the Newark Mineralogical Society was held May 6th with eleven members present out of a total membership of twenty-three. During the past season Dr. Colton has been giving at each meeting a talk on crystallography. These talks have proved of great value to all members. At this, the last meeting (indoors) for the season, the talk on the Monoclinic System was postponed and Mr. Reuben Broadbent, of Broken Hill, Australia, gave us a lecture on "Australia: Its Mines and Minerals," illustrated with lantern slides and mineral specimens. At the close of the meeting a vote of thanks was extended to Mr. Broadbent for his kindness in presenting this lecture before us.

Our next meeting in the clubrooms will be held the first Sunday in October at the Newark Technical School, 367 High St., where we will be pleased to welcome anyone interested in mineralogy. Our next meeting, which will be a field meeting, will be held somewhere in the field, date and place as yet unannounced.

WM. H. BROADWELL, *Secretary*.

NEW YORK MINERALOGICAL CLUB

The meeting of Wednesday, April 11th, 1917 was held in the Club room, the President, Mr. J. G. Manchester, in the chair.

The paper of the evening was by Mr. Reuben Broadbent on "Australia and some of its Mines and Minerals."

Mr. Broadbent, a native of the country described, gave a sketch of its interesting history, present aspects, and political or rather natural physiographic divisions and a similar review of some of its mines and mining districts—especially those of Broken Hill, New South Wales. Both these reviews were illustrated with lantern slides of maps and views of the cities, mining districts, and mills described.

His pictures of the machinery employed for the rather new "Flotation method" of concentration gave a realistic impression of the magnitude of its application in the Broken Hill District.

His description of the minerals of the various localities was illustrated with very attractive specimens from his own collection and a supplementary selection from the collection in the Am. Mus. of Nat. History of N. Y. contributed by Dr. L. P. Gratacap.

At the conclusion of his paper Mr. Broadbent supplied much additional information in replies to questions by the members present.

The attention of the meeting was then given to a large garnet crystal found at 168th St. and Broadway, N. Y. B. M. and exhibited by Mr. Charles W. McDonald, the contractor who was grading the plot where it occurred. Several visits were made by members of the Club to the locality from time to time during the progress of the excavation but nothing else of special interest seems to have occurred there.

WALLACE GOULD LEVISON, *Secretary*.



Fig 1 KUNZ COLLECTION

(1)

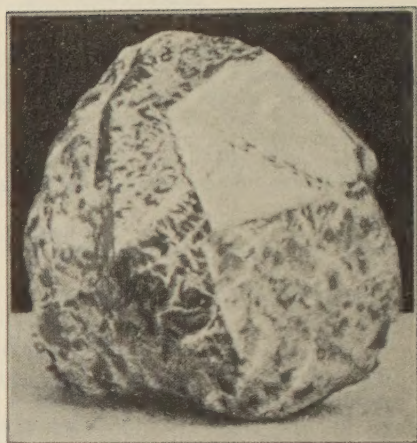


Fig. 2. MANCHESTER COLLECTION

(2)

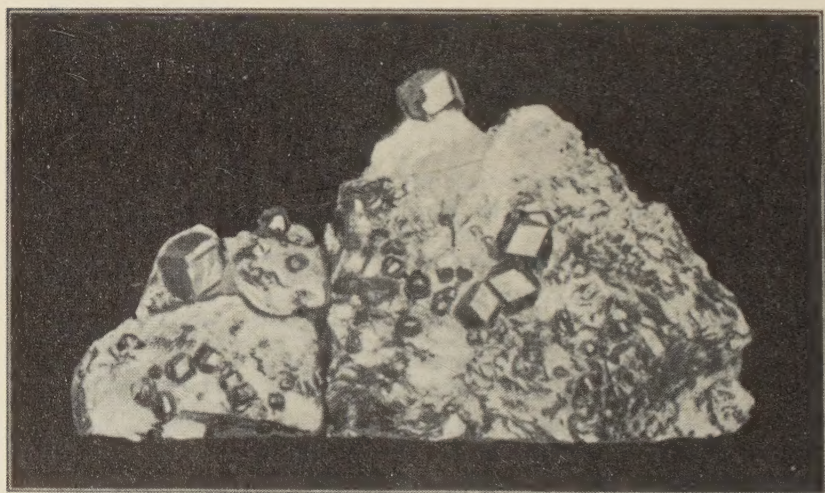


Fig. 3. STANTON COLLECTION

(3)

NEW YORK CITY GARNETS

FROM "THE MINERALS OF BROADWAY," BY J. G. MANCHESTER
BULL. NO. 3, NEW YORK MINERALOGICAL CLUB

PLATE III